Digital Radio Mondiale (DRM)

digital long-, medium- and shortwave radio

by H. Weber

Even shortwave is now going digital! This year, field trials of a new transmission method got under way, involving shortwave listeners and radio amateurs from all over the world. A ‘concept’ receiver was demonstrated at this year’s International Broadcasting Conference (IBC) in Amsterdam, and transmissions are officially scheduled to start in June 2003.

The use of radio frequency bands below 30 MHz — long-, medium- and shortwave — has been in continuous decline over recent years. The main reason for this is poor sound quality. The channels used for programme transmission are very narrow: 9 kHz on medium- and longwave, 10 kHz on shortwave. Amplitude modulation, as used to date, is certainly technically very straightforward, but not very efficient. In particular, shortwave is very prone to interference. However, by using more sophisticated modulation schemes and modern data compression techniques it is possible to transmit ‘near-CD’ quality radio in this frequency band. Then the advantages of shortwave, its long range and lack of dependence on satellite operators or Internet service providers, come into their own.

Development

After pioneering systems designed and tested as part of the German T2M project (**Figure 1**), the French company Thomcast (now known as Thales) developed the ‘Skywave 2000’ system which uses a large number of carriers (at least 47) with a separation of 66.666 Hz. This gives a relatively long data symbol time. The technique is also known as ‘slimmed-down DAB’. The technique is indeed reminiscent of DAB, using COFDM (coded orthogonal frequency division multiplex), but is however limited to a much narrower bandwidth. Skywave 2000 allows for a transition period where analogue and digital signals are broadcast simultaneously.

The individual carriers are modulated using QAM (quadrature amplitude modulation), a form of APSK (amplitude and phase shift keying) where two signals at a 90-degree phase offset are amplitude modulated at various set levels and then added together. With four such levels a total of sixteen modulation states (or data symbols) are possible (16-QAM); with eight levels there are sixty-four (64-QAM).

In March 1998 the Digital Radio Mondiale (DRM) consortium was founded, consisting of over seventy companies and other organisations, to set up a framework for international standardisation. The consortium included big foreign service broadcasters such as the BBC, Deutsche Welle and Radio Netherlands, as well as transmitter manufacturers (such as Thales, Telefunken and Harris) and receiver manufacturers (such as Sony and Sangean).

The participants in the consortium took over a year to come to an agreed plan. COFDM was chosen as the transmission technique, being the method favoured by the French participants. Some elements from other systems, in particular regarding error detection and correction, also influenced the final standard. The main modulation scheme selected was 64-QAM, with 16-QAM, offering improved resistance to interference at the cost of lower quality, also available.

The conversion of audio signals into a digital data stream, or 'source coding', employs Advanced Audio Coding (AAC), for which dedicated integrated circuit implementations are available. AAC should not be confused with MP3, despite the fact that they were developed at the same institution. As far as data compression is concerned, AAC is superior to MP3, and it is especially suitable for the low bit-rate data stream demanded by narrow-bandwidth transmission over shortwave.

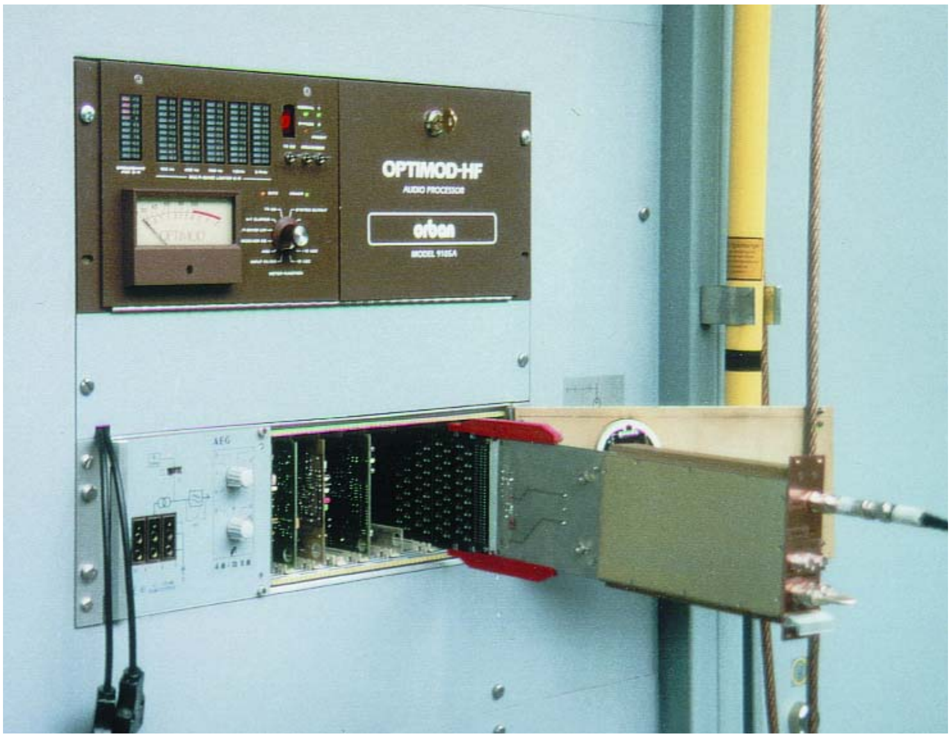

Figure 1. Early trials of digital transmissions over shortwave were carried out in April 1996 at the Jülich transmitter near Cologne using this plug-in card (photo: H. Weber).

A technique called SBR (spectral band replication) is employed to improve the audio bandwidth still further. Broadly speaking, the frequencies above 6 kHz are regenerated by synthesising harmonics. This extends the audio bandwidth to 15 kHz, without having to transmit the information in the higher frequency range.

The idea of simultaneous transmission of analogue and digital signals on the same frequency seems to have been abandoned. Instead, set frequency bands will be reserved

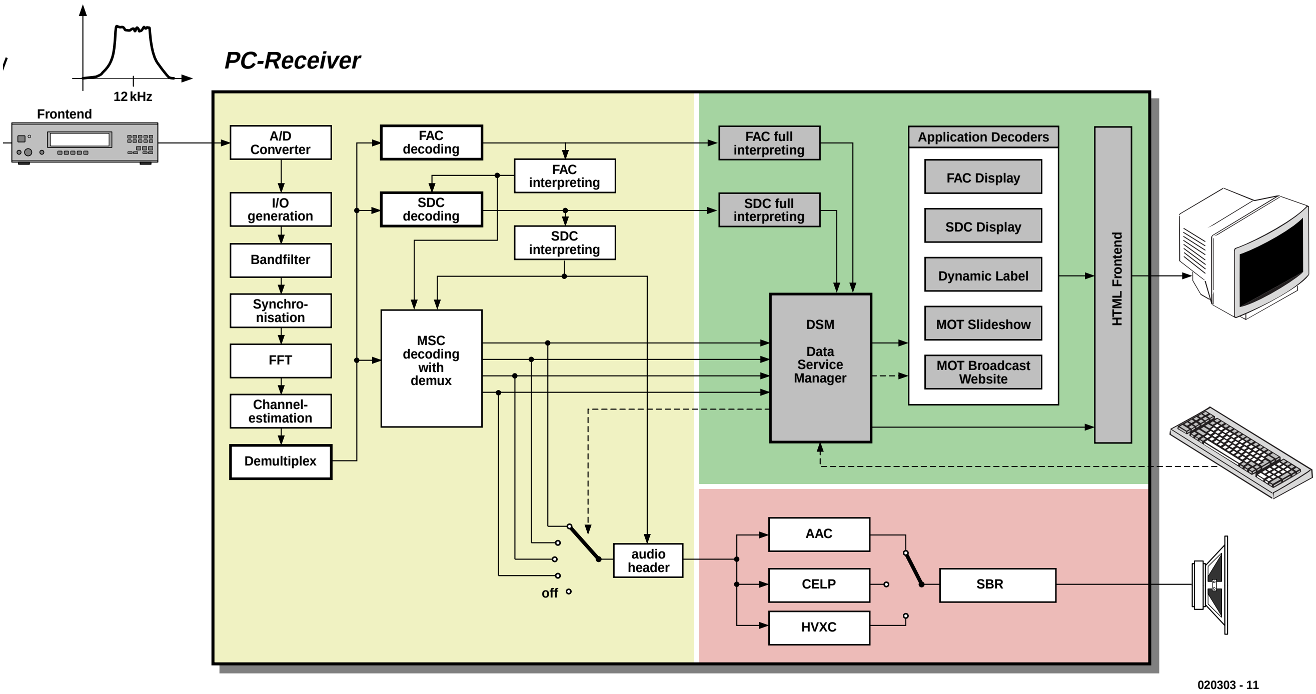

Figure 2. Block diagram of a DRM software receiver (courtesy Fraunhofer Institute for Integrated Circuits).

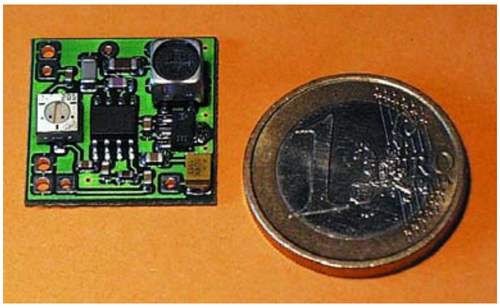

Figure 3. The 'mixer chip' circuit board used for modifying a world receiver for DRM reception (courtesy Sat-Service Schneider).

for DRM in order to prevent mutual interference. In April 2001, the DRM standard was adopted by the ITU (International Telecommunications Union) as a recommendation to its member countries. The way is now clear for the technology to be used worldwide.

Field trials

The next step is a trial period planned for two years in which radio amateurs and shortwave listeners from all over the world can (and should) take part. Trials start at the end of this year. A 'light' version of the professional receiver software (see **Figure 2**) is being made available to participants, which has already been used over the last year to receive test transmissions for evaluation. The software not only decodes the transmission, but also checks the reception quality and reports back to DRM.

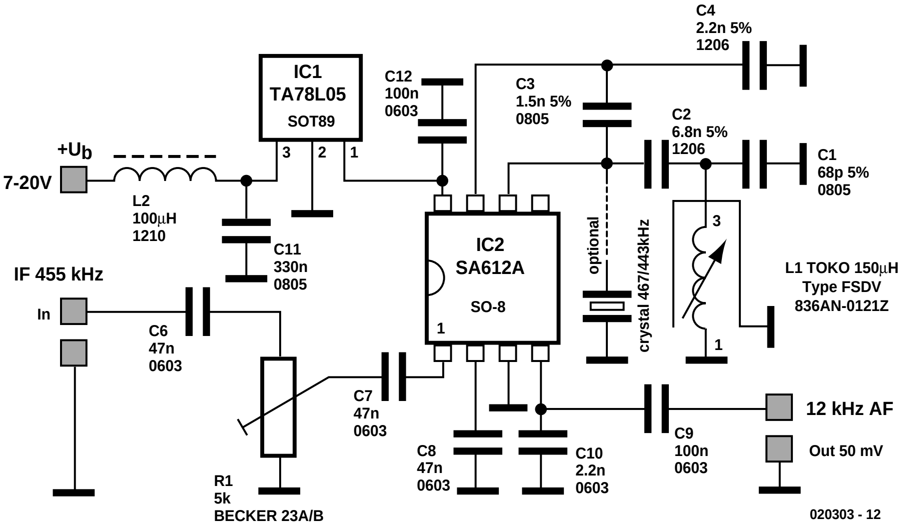

Figure 4. Circuit of the LC-mixer (courtesy Sat-Service Schneider).

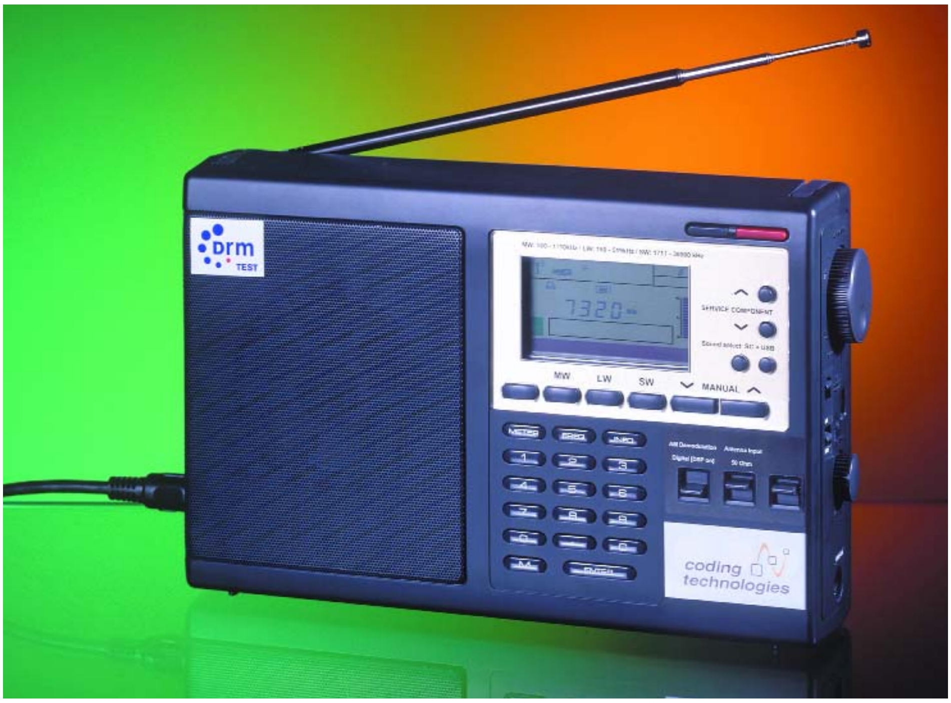

Figure 5. First 'concept' DRM receiver (courtesy Coding Technologies).

To take part, a high-end PC and a shortwave receiver in the middle-to-high price bracket is needed (for example, the AOR 7030 or Yaesu FRG 100). This is modified using a 20 mm square add-in circuit board (or 'mixer chip' — see **Figure 3**), which generates a 12 kHz intermediate frequency. This is required to drive the soundcard of the PC. The receiver must also be adapted for a bandwidth of 10 kHz, since the filter normally used (which typically has a bandwidth of 6 kHz) will not let the whole DRM signal through.

The printed circuit board required for the modifications can, for example, be obtained from Sat-Service Schneider in Germany. The LC version (**Figure 4**) does the conversion job for under 40 euros; the quartz crystal version is almost twice as expensive. If you are not prepared to modify your equipment yourself, a professional fitting service is available. A complete, modified receiver is available for around £ 500 (799 euros); the receiver software costs a further £ 38 (60 euros).

Receivers

Of course, only being able to receive DRM transmissions with a PC is no long-term solution. A 'concept' DRM world receiver (**Figure 5**) was demonstrated at the IBC in September in Amsterdam. This was developed by Coding Technologies, a Swedish-German company, in conjunction with the BBC and AFG, a terminal equipment manufacturer. In this receiver the functions which would have been performed in the PC software are realised in an add-in module (the 'TriMedia DSP' in the block diagram of **Figure 6**).

Other companies are also working on DRM receivers. Sat-Service Schneider also intends to bring to

DRM websites:

www.drm.org
(general DRM information)

www.drmrx.org
(includes registration to participate in the DRM trials)

www.rnw.nl/realradio/html/drm.html
(Radio Netherlands World Service DRM pages)

www.CodingTechnologies.com
(DRM receivers)

www.iis.fraunhofer.de/dab/products/drmreceiver/index.html
(FhG software radio)

www.sat-schneider.de
(DRM receivers and components for modifying receivers)

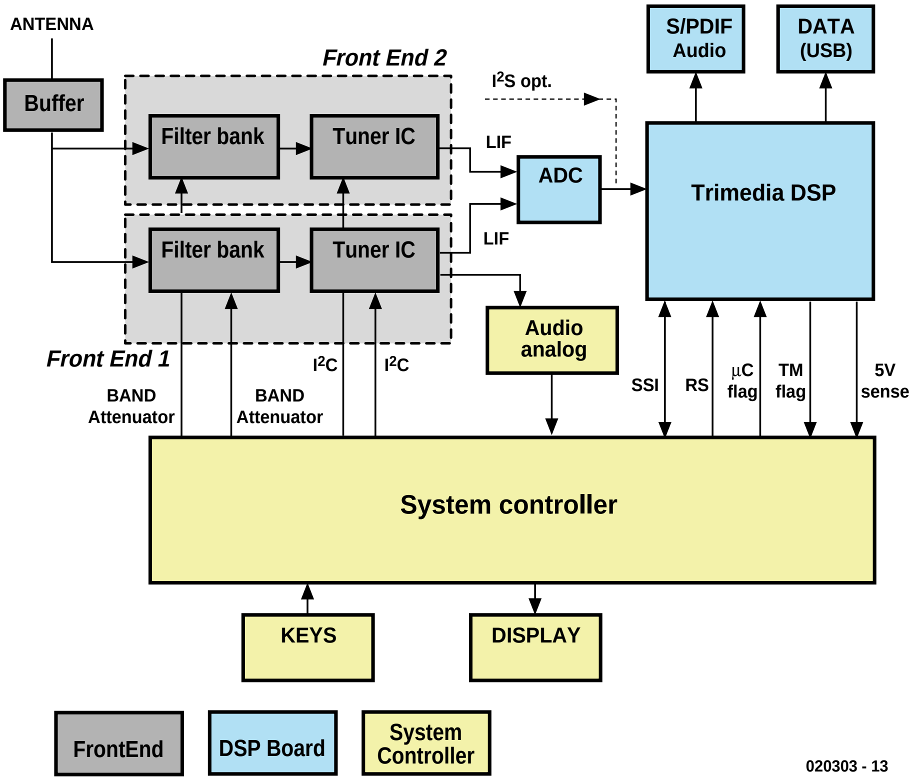

Figure 6. Block diagram of a DRM receiver (courtesy Coding Technologies).

market its own mini-receiver (whose block diagram is shown in **Figure 7**).

Starting in June

DRM transmissions will officially start after the World Radio Conference, which takes place in June next year. By then the first receiver models will be in production and available in the shops. At first the receivers are expected to be rather expensive; but after the initial period, when mass production begins, the equipment is expected to be 'only a little more expensive' than existing sets. They must support both analogue and digital transmission modes, since the transition will necessarily be gradual. At the earliest analogue transmissions will stop in fifteen years time; in poorer countries somewhat later still.

Most of the big and many of the small shortwave broadcasters have expressed an interest in DRM. Modern transmitters can be modified relatively easily to allow DRM transmissions to be made.

Mediumwave could also experience a Renaissance through improved sound quality; in some cases broadcasters are already using mediumwave for digital transmissions.

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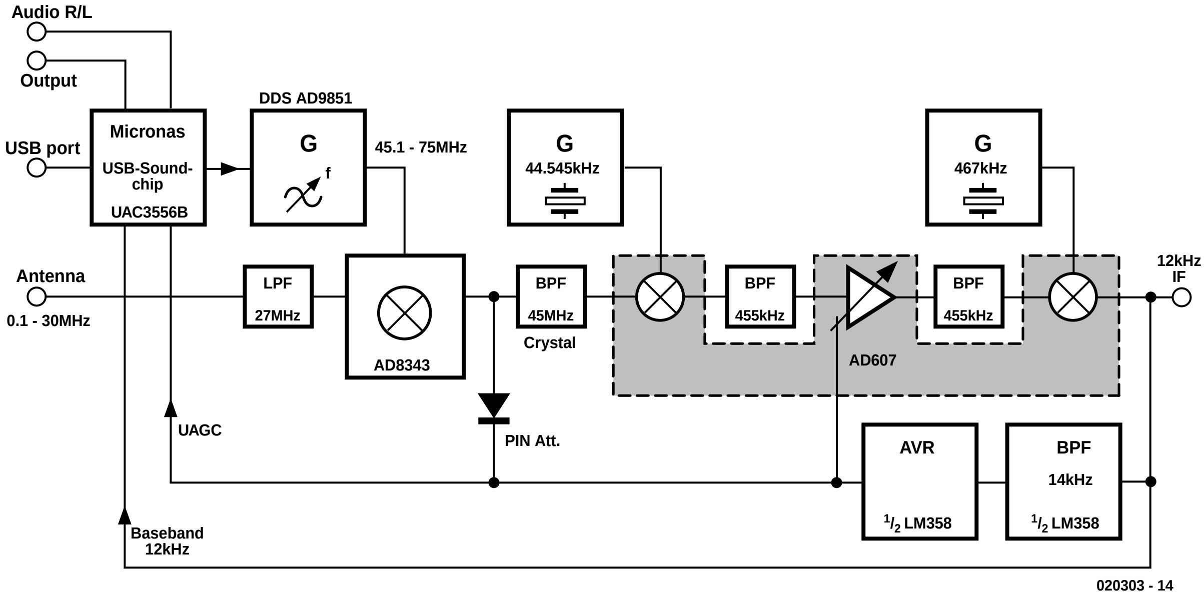

Figure 7. Block diagram of a DRM mini-receiver (courtesy Sat-Service Schneider).